



Electromagnetic Railgun

**ASNE Combat System
Symposium
26-29 March 2012**

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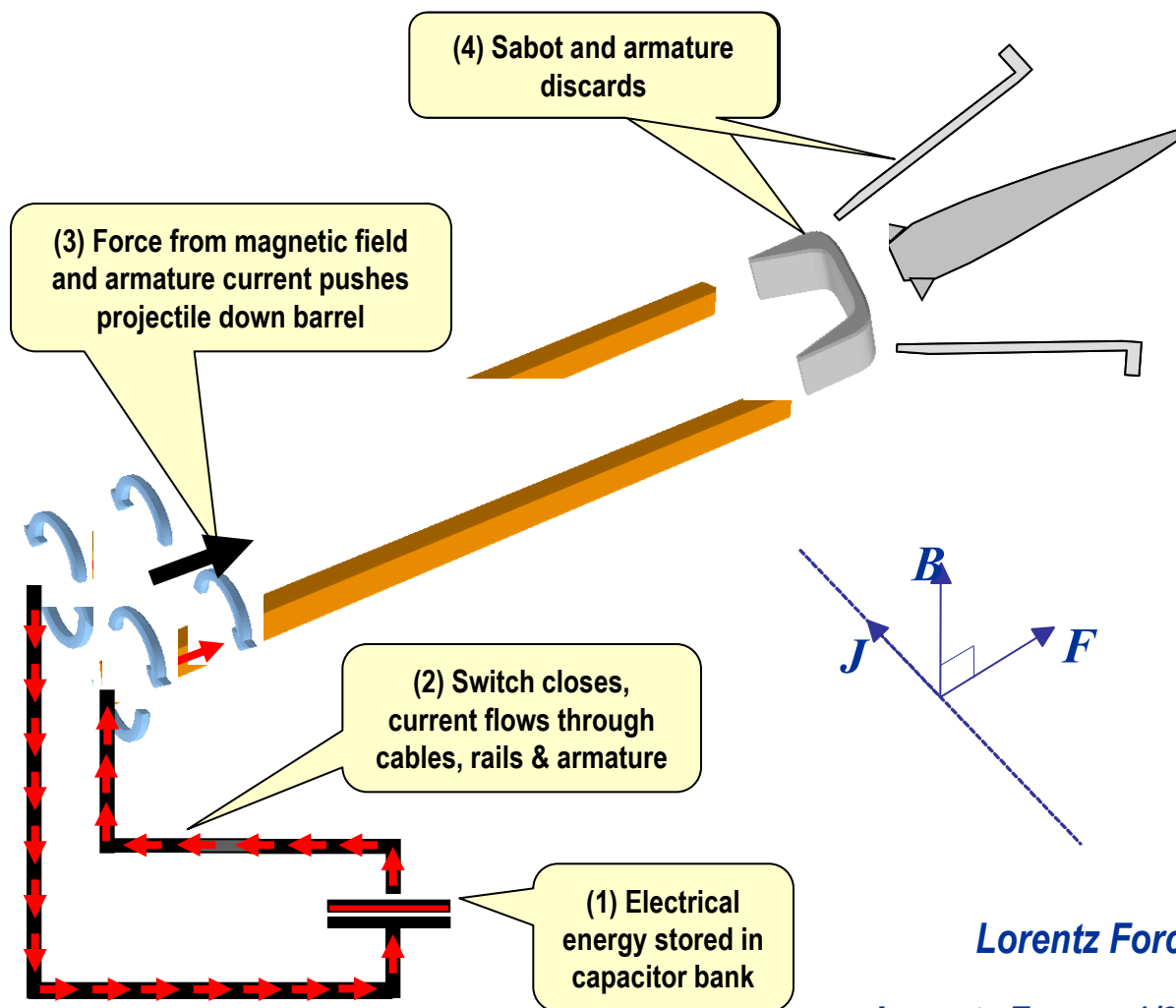


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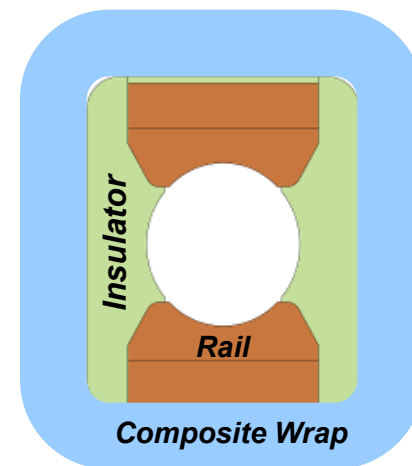
How Railgun Works



Operating Principle



Cross-Section



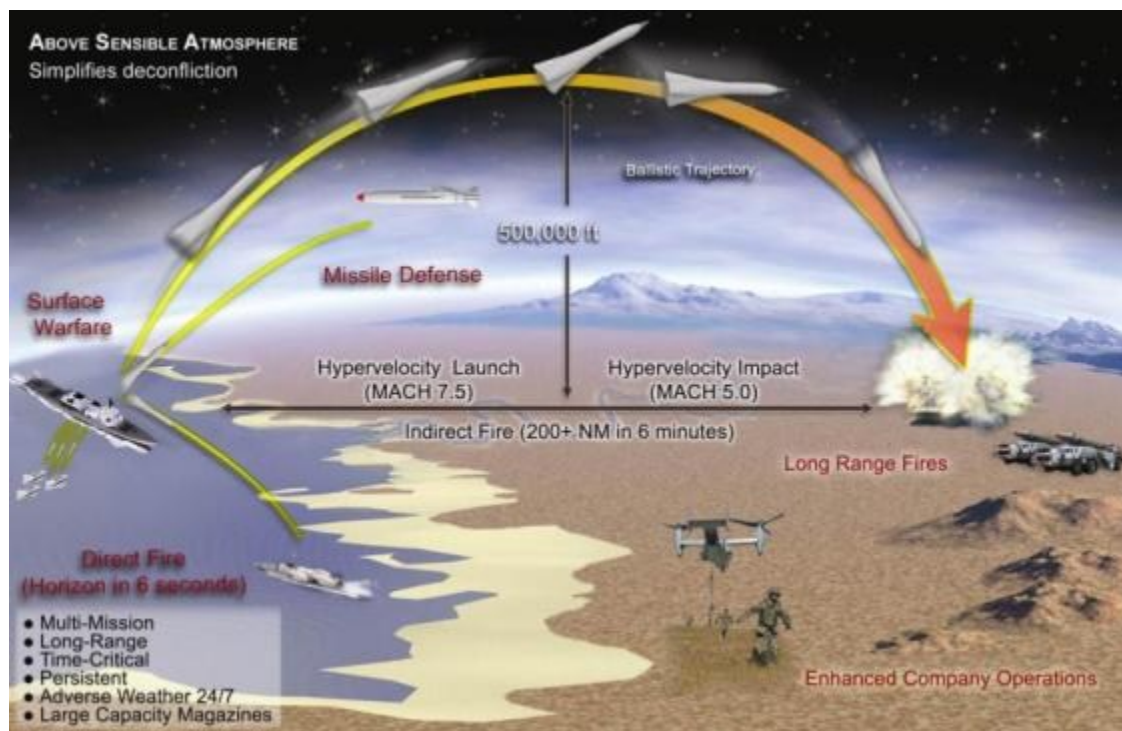
$$\text{Lorentz Force} = \text{Current } (J) \times \text{Magnetic Field } (B)$$

$$\text{or} \\ \text{Lorentz Force} = 1/2 \text{ Inductance Gradient } (L') * \text{Current } (I)^2$$

Railgun Operational Impact



- **Wide Area Coverage**
 - Increased speed to target
 - 200+ NM
- **Accelerates operational tempo**
 - Faster attrition of enemy personnel and equipment
 - Operation timeline shifts left
- **Reduces Cost per Kill**
 - Lower Unit Cost
 - Lower handling cost
- **Enhances Safety**
 - No risk of sympathetic detonation
 - Simplified storage, transportation and replenishment
 - Reduced collateral damage
 - No unexploded ordnance on battlefield
- **Reduces Logistics**
 - Eliminates gun powder trail
 - Deep magazines



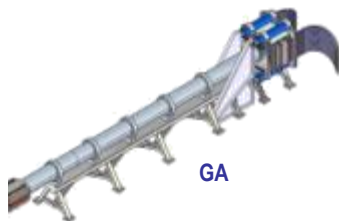
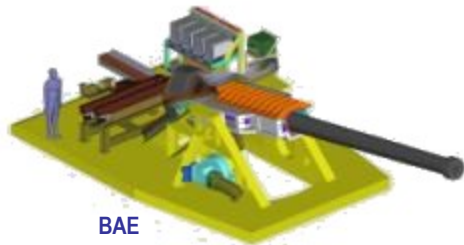
- **Multi-Mission Capability**
 - Surface Warfare
 - Missile Defense
 - Long Range Fires
 - Direct Fire
 - ASuW

Multi-Mission Capable for Offense and Defense

Naval Railgun – Key Elements

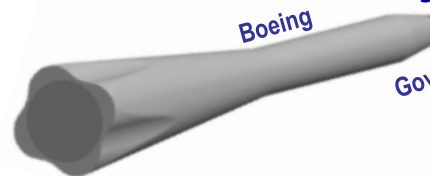


Launcher



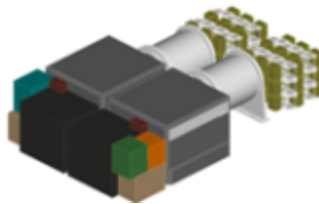
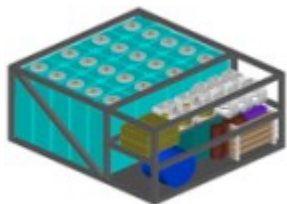
- Multi-shot barrel life
- Barrel construction to contain rail repulsive forces
- Scaling from 8MJ (state of the art) to 32MJ to 64MJ Muzzle Energy
- Thermal management techniques
- M&S – Represent interaction between bore and projectile

Projectile



- Dispensing and Unitary Rounds
- Gun launch survivability
 - 20-45 kGee acceleration
 - Thermal Risk Management
- Hypersonic guided flight for accuracy
- Lethality mechanics

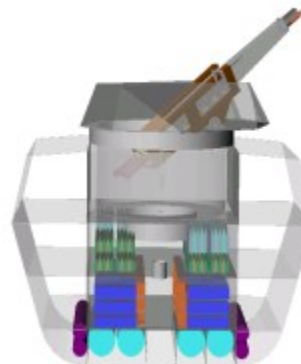
Pulse Forming Network (PFN)



Capacitors or Rotating Machines

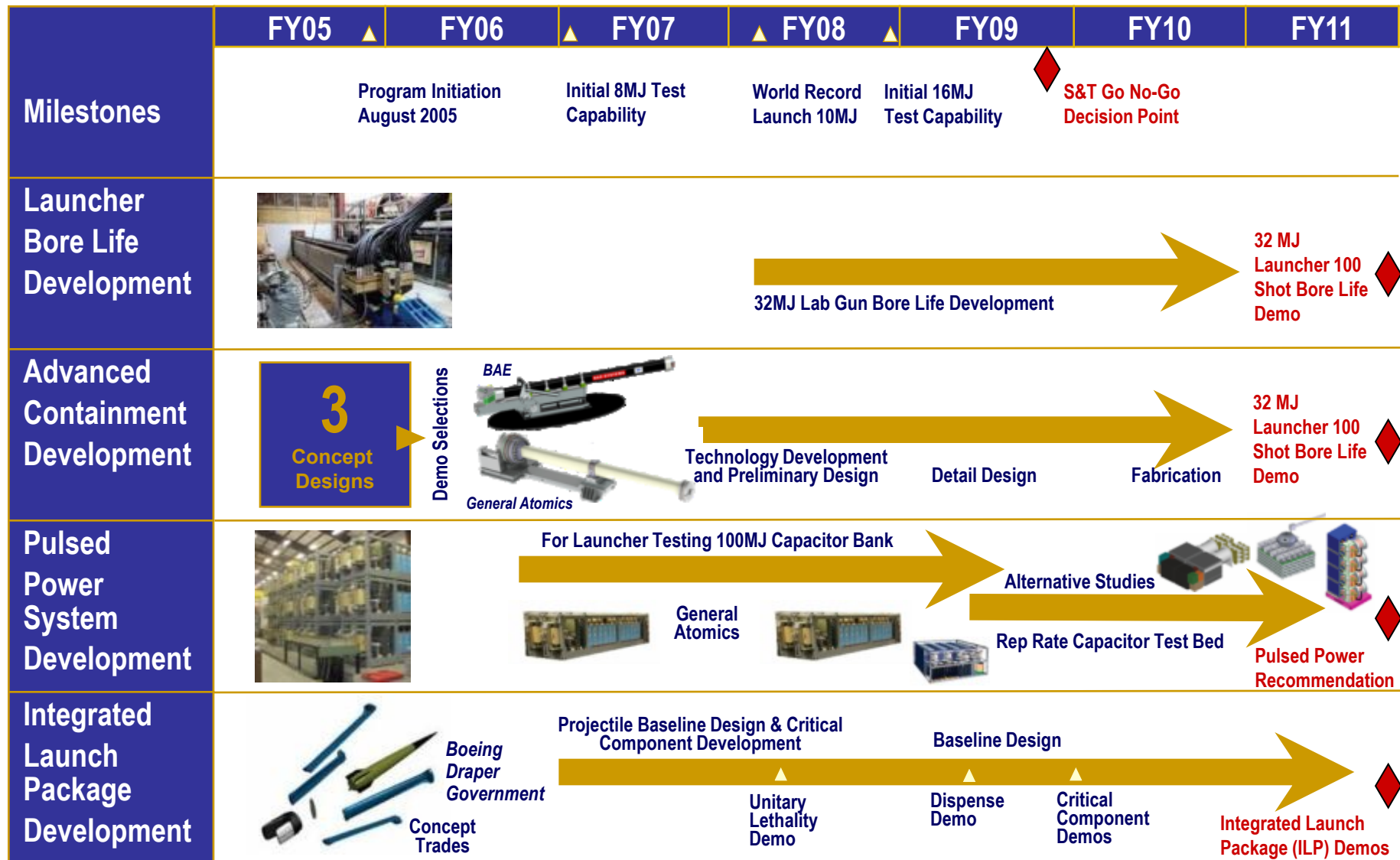
- Energy Density
- Rep rate operation & thermal management
- Switching
- Torque management and multi-machine synchronization (rotating machine)

Ship Integration



- Dynamic Power Sharing
- Space and Weight
- Thermal and EM Field Management

EM Railgun INP Phase I





Lab Launcher



GA Med-Cal Blitzer (IRAD)



Rep-Rate Test Bed



BAE 5M Prototype



Dispense Test

- Muzzle energy:
 - From 6MJ to 32MJ
- Bore Life
 - From 10s to 100s
 - Multiple configurations & materials
- Industry Launcher Prototypes
 - From concept to hardware
- Pulsed power
 - From single shot
 - To multi-shot capable design
- Projectile
 - From slugs & sand catch
 - To instrumented and dispensing flight bodies on open range
- Mission
 - From Land Attack
 - To Multi-Mission Initiative

Advanced Containment Launchers

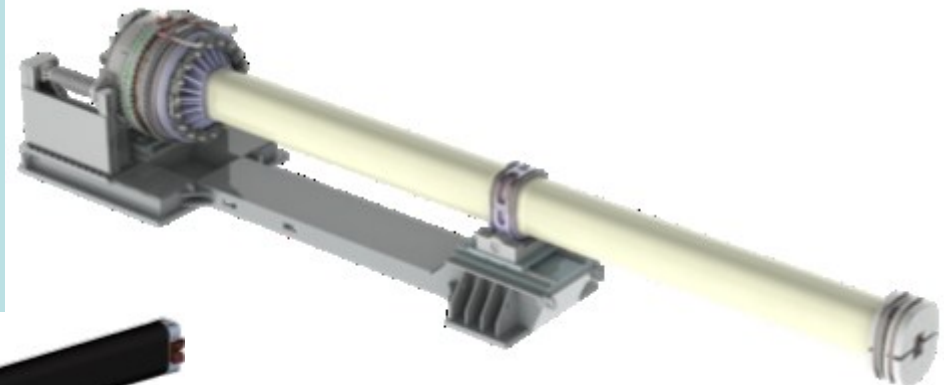


The industry developed Advanced Containment Launchers (ACLs) detailed designs are competition sensitive and each include unique materials, however they both share the following attributes:

- Advanced composite containment designs
- Advanced insulator materials



GA 10-meter ACL

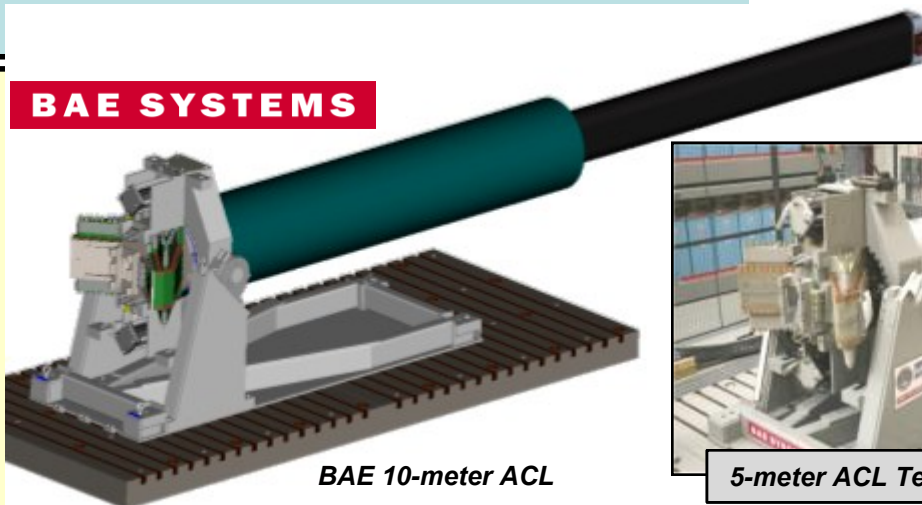


'Blitzer' Testing at DPG



- Subscale ACL launcher ('Blitzer') built by GA to provide risk reduction. Multiple test series have been completed at Dugway Proving Grounds (DPG), Utah
 - Full-scale 10-meter ACL in production
 - GA 10-meter ACL scheduled to be delivered to the Electromagnetic Launch Facility (EMLF) at NSWC Dahlgren and complete testing during the 1st quarter of FY2012

BAE SYSTEMS



BAE 10-meter ACL

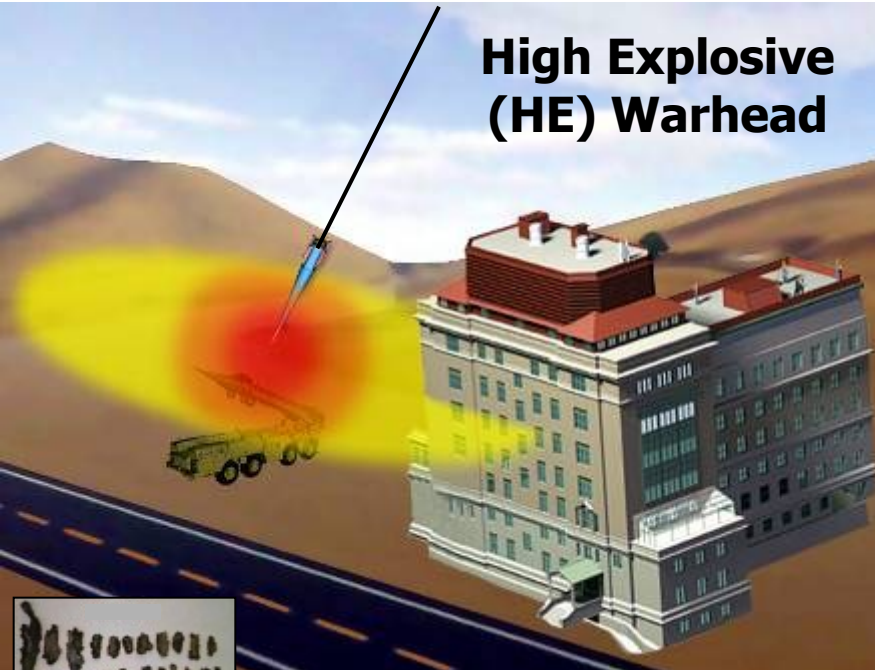


5-meter ACL Testing at EMLF

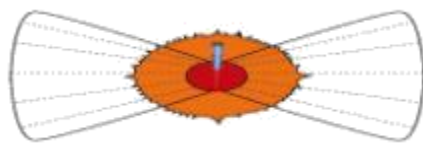
- 5-meter version of 10-meter ACL recently tested at EMLF (1/2011) with full-scale bore (cross-section), breech, muzzle and mount.
 - Full-length ACL in production.
- BAE 10-meter ACL scheduled to be delivered to the Electromagnetic Launch Facility (EMLF) at NSWC Dahlgren and complete testing during the 4th quarter of FY2011

HE versus KE Projectiles

High Explosive (HE) Warhead

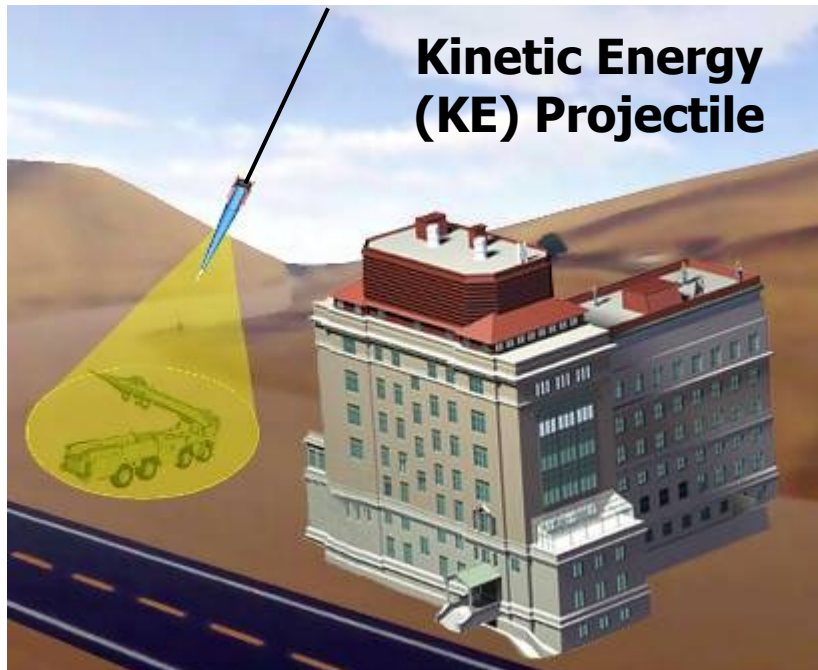


Non-uniform frags

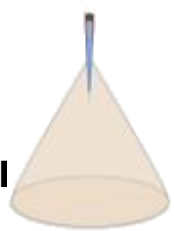


- **Blast Overpressure**
- **Large Area of Fragment Spray**
- **High Collateral Damage**

Kinetic Energy (KE) Projectile



Uniform frags



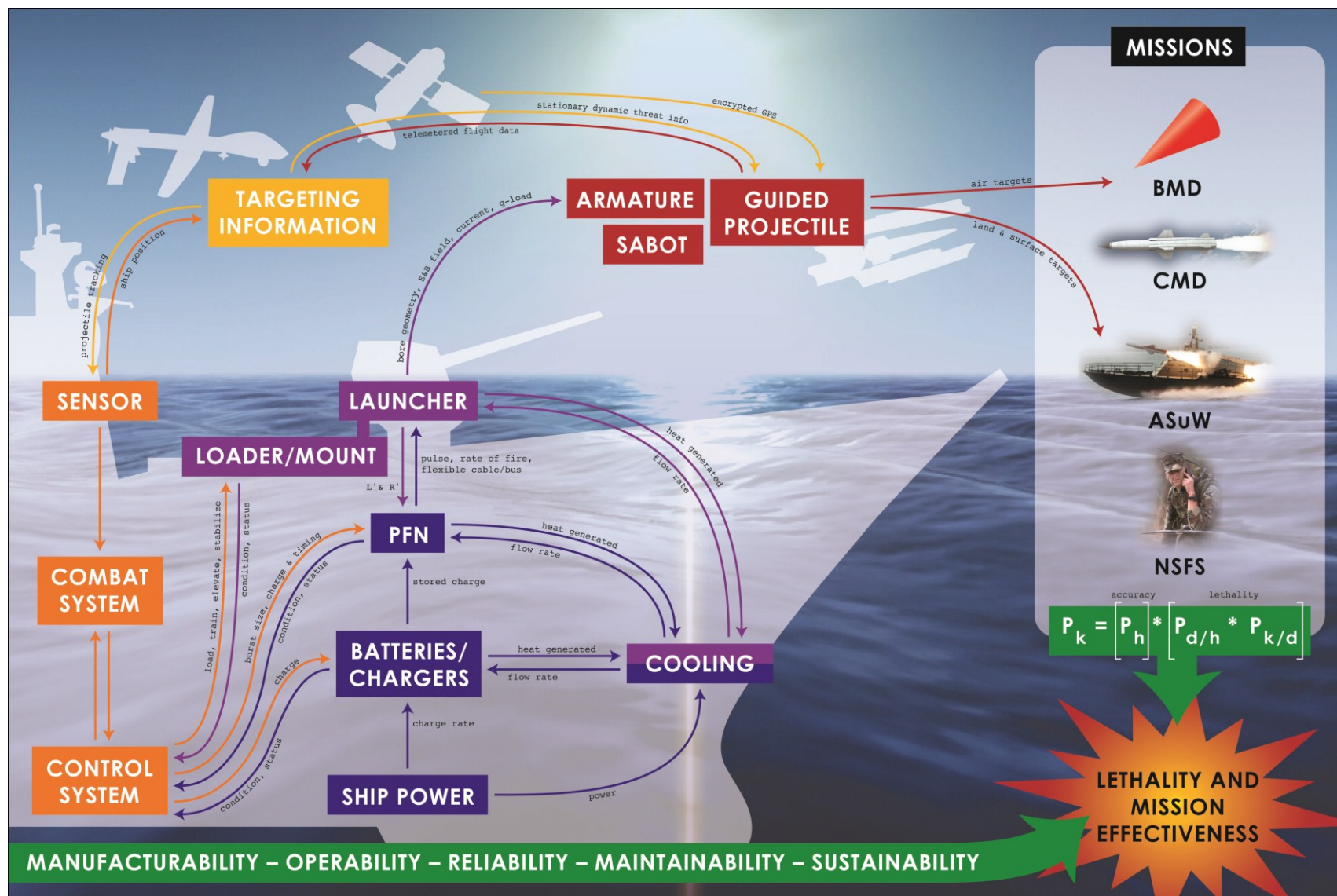
- **No Blast Overpressure**
- **Focused Fragment Pattern**
- **Minimal Collateral Damage**

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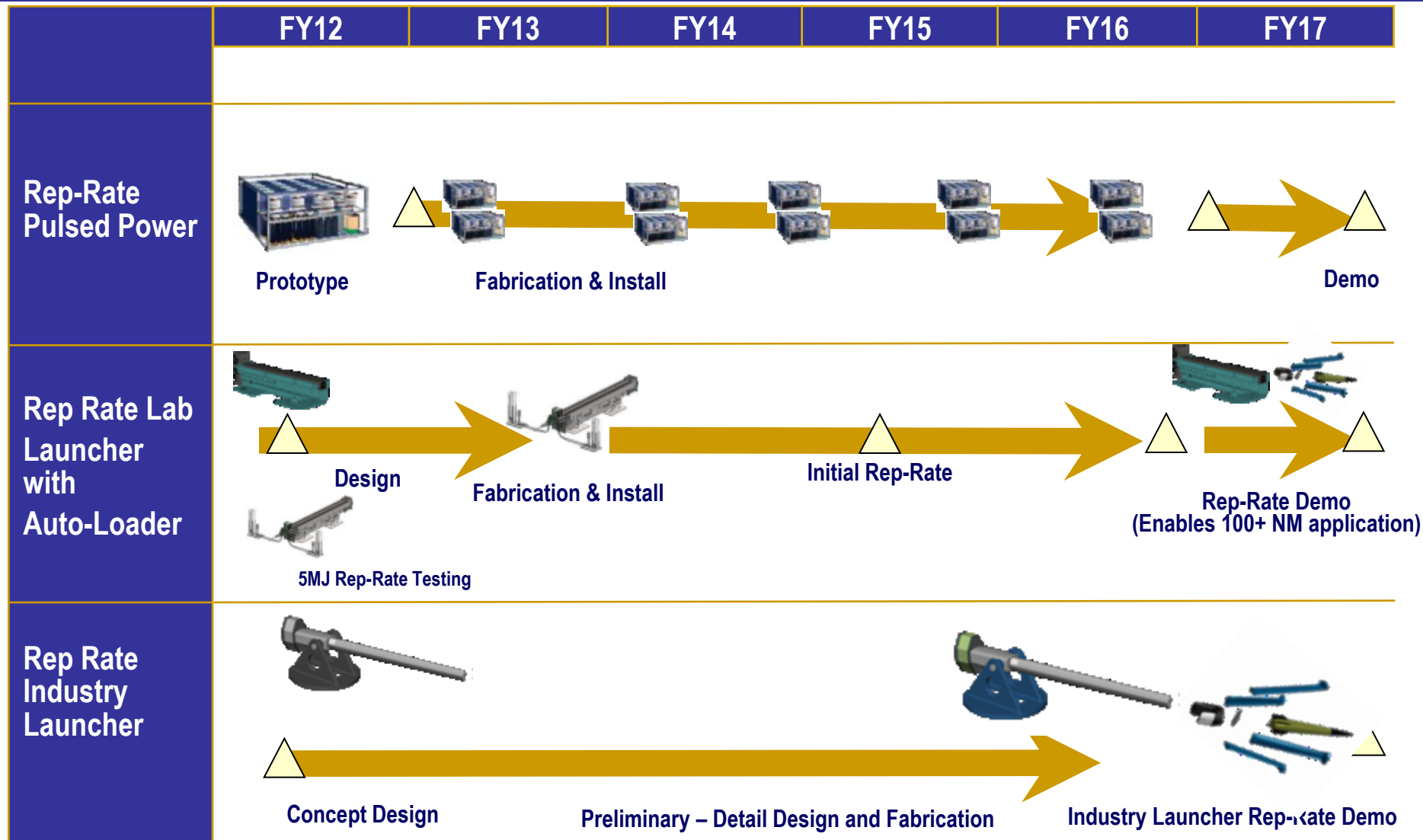


Pulsed Power at the Electromagnetic Launch Facility, Dahlgren, VA

Railgun System Integration



EM Railgun INP Phase II



INP II Focused on Rep-Rate and Thermal Management

- Naval EM Railgun is a “Navy after Next” Game Changer
- Risk Mitigation
 - Barrel Life Development
 - Advanced Containment Launchers – Competitive solutions
 - Critical Projectile Components
 - Understanding Ship and Weapons System Integration Requirements

Challenges Understood and Being Addressed